

B5
Q2
cont.
Claim 2 wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.

Q3
28 (Amended) A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film on the insulating film formed on a substrate, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing using a polishing slurry comprising a silica polishing material and an inorganic salt, wherein the inorganic salt in the polishing slurry used in polishing is at least one selected from the group consisting of a hydroacid salt, an oxo acid salt, a peroxo acid salt and a halogen oxo acid salt.

REMARKS

The Office Action has objected to Claim 2 under 37 C.F.R. §1.75(c). In addition, Claims 1, 8, 10-11, 28 and 31 are rejected under 35 U.S.C. §102(b) as defining subject matter which is allegedly described in JP-08-83780 ("Japanese reference"). In addition, Claims 2-9, 13-26 and 29 are rejected under 35 U.S.C. §103(a) as defining subject matter which is allegedly rendered obvious by the teachings in Japanese reference in view of WO 00/52230 of which Kyle is an inventor ("Kyle"). Claims 12 and 32 are rejected under 35 U.S.C. §103(a) as defining subject matter which is allegedly rendered obvious by the teachings in the Japanese reference in view of applicants' admitted prior art on page 3 of the instant specification ("AAPA"). Claims 22 and 27 are rejected under 35 U.S.C. §103 as defining subject matter which is allegedly rendered obvious by the teachings in the Japanese reference and Kyle and further in view of AAPA.

Applicants have amended the claims, which when considered with the comments hereinbelow are deemed to place the present case in condition for allowance. Favorable action is respectfully requested.

Claim 2 has been amended by identifying the polishing step referred to therein as the "first polishing step." Support for the amendment to Claim 2 is found on Page 13, lines 9-14 of the instant specification. In addition, the term "both" which is superfluous therein has been deleted.

Claim 12 has been amended by making it dependent on Claim 2. Claim 28 has been amended by incorporating therein the subject matter of original Claim 29.

No new matter is added to the application.

A marked-up version showing the amendments to the claims is appended to the amendment. It is entitled "Marked-up Version to Show Changes Made".

Pursuant to the objection of Claim 2 under 37 C.F.R. §1.75(c), the Office Action alleges that the claim fails to limit Claim 1 upon which it depends. Claim 2, as amended, provides a further limitation to the first polishing step recited in Claim 1. Thus, as amended, Claim 2 further limits the subject matter of Claim 1. Therefore, the objection to Claim 2 under 37 C.F.R. §1.75(a) is overcome, withdrawal thereof is respectfully requested.

Pursuant to the rejection of Claims 1, 8, 10-11, 28 and 31 under 35 U.S.C. §102(b), the Office Action cites the Japanese reference.

The present invention, including the subject matter of Claim 1 et seq. is directed to, inter alia, a process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave

is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal to the barrier metal to 1 to 3 both inclusive, until the surface of the insulating film other than the concave is substantially completely exposed. It is to be noted that in the second polishing step, the polishing rate ratio of the interconnect metal to the barrier metal ranges from 1:1 to 3:1, inclusive.

The Japanese reference discloses an abrasive and polishing method for polishing a substrate composed of a silicon substrate and a silicon oxide film and carbon film successively formed on the silicon substrate. In the process described therein, grooves for wiring, openings for continuous wirings and the like are formed in both the silicon oxide film and the carbon film by patterning, and a titanium nitride film and copper film are successively formed on the surface of the substrate. The copper film has recesses and projecting sections thereon, and it is formed at a high polishing speed by filling up the recessed section by using a chemimechanical polishing method using an abrasive prepared by dispersing silica particles as abrasive particles in a mixed solution of a glycine and hydrogen peroxide and adding benzotriazole to the mixed solution. It is alleged that this method also suppresses the occurrence of dishing.

According to the Office Action, the Japanese reference teaches all of the elements of the claims. Applicants disagree.

Anticipation requires that the prior art reference disclose each and every element of the claim. Kalman v. Kimberly Clark Corp., 713 F2d 760, 771, 218 USPQ 781, 789 (Fed. Cir.

1983). The absence of any one element negates anticipation. Id., 713 F2d at 771-772, 218 USPQ at 789.

Contrary to the allegations in the Office Action, there are differences between the present invention and the prior art references. For example, the reference fails to teach or disclose the polishing ratio of the second polishing step wherein the polishing rate ratio of the interconnect metal to the barrier metal is 1:1 to 3:1, inclusive.

The Office Action agrees. However, the Office Action alleges that the polishing rate ratio is an inherent characteristic of the material. Applicants disagree.

Case law has held that in order for a disclosure to be inherent, the missing descriptive matter must necessarily be present in the thing described in the reference and that it would be so recognized by persons of ordinary skill. Continental Can Co. v. Monsanto Co., 948 F2d. 1264, 1268, 20 USPQ2d. 1746, 1749 (Fed. Cir. 1991). Inherency, however, may not be established by probabilities or possibilities; the mere fact that a certain thing may result for a given set of circumstances is not sufficient. Id., at 1269, 20 USPQ 2d at 1749.

Contrary to the Office Action, the polishing rate ratio of the interconnect metal to the barrier metal film is not a characteristic inherent in the material. Attention is directed to the instant disclosure on Page 14, line 9 to page 15 line 24. As described therein, it is possible that the ratio can be less than 1 or more than 3. Polishing can be effected outside these claimed ranges, although as indicated in the instant specification, problems arise when conducted outside of the claimed range. Moreover, there is no teaching or suggestion in the prior art reference which limits the ratio to 1:1 to 3:1. On the contrary, the prior art reference discloses rate ratio may be less than 1. Attention is directed to Example 1, wherein it is taught that the polishing of the copper layer (25), corresponding to the interconnect layer, progresses more "slightly" than

polishing of the titanium nitride layer (24) (barrier metal layer). This teaching means that the polishing rate ratio of the interconnect layer to barrier metal is less than 1. Thus, contrary to the allegation of the Office Action, the claimed ratio which is an element of the claims is not inherent in the Japanese reference. Thus since the Japanese reference does not teach or disclose the claimed rate ratio, the subject matter in Claims 1, 8, 10 and 11 is not taught or described in the prior art.

With respect to the subject matter of Claims 28 and 31, applicants reiterate the above comments. In addition, the subject matter therein contains another element not present in the prior art, i.e., the presence of an inorganic salt selected from the group consisting of a hydroacid salt, oxo acid salt, a peroxo acid salt and a halogen oxo salt in the chemical mechanical polishing slurry used in the present process. The Japanese reference does not utilize such salts in the chemical mechanical polishing slurry used in the process described therein.

This subject matter identifying the type of salts was originally in Claim 29, which by amendment, is incorporated into Claim 28. Thus, since Claim 29 was not rejected by the United States Patent and Trademark Office, it also agrees that the subject matter is not anticipated by the teachings in Japanese reference.

This, for the reasons given, the rejection of Claims 1, 8, 10-11, 28 and 31 are under 35 U.S.C. §102(b) is obviated; withdrawal thereof is respectfully requested.

Pursuant to the rejection of Claims 2-9, 13-26 and 29 under 35 U.S.C. §103(a) the office Action cites the Japanese reference in view of Kyle, et al.

The Office Action alleges that the Japanese reference fails to show the polishing slurry comprising an alkanol amine and a carboxylic acid. The Office Action alleges that Kyle, et al. disclose this element.

However, Kyle, et al. is not a reference to this application. It was published on September 8, 2000; the present application is claiming benefit of JP-11-374487, which was filed on December 28, 1999. Thus, the present application has an effective filing date of December 28, 1999, which antedates the secondary reference. Thus, Kyle, et al. cannot be used as a reference and thus Kyle, et al. cannot be combined with the primary reference to reject the claims. Since even the United States Patent and Trademark Office admits that the Japanese reference alone does not teach or disclose or suggest that present invention, the rejection of Claim 2-9 and 13-26 under 35 U.S.C. §103(a) is obviated; withdrawal thereof is respectfully requested.

Pursuant to the rejection of Claims 12 and 32, the Office Action cites the Japanese reference and the AAPA on Page 3 of the instant specification.

The subject matter of Claim 12 is directed to a process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal to the barrier metal to 1 to 3 both inclusive, until the surface of the insulating film other than the concave is substantially completely exposed, wherein the first polishing step is conducted such that the interconnect metal film remains in 5% to 30% inclusive of the surface area other than the concave and wherein the interconnect film is a copper or copper alloy film and the barrier metal

film is a tantalum-containing metal film. The subject matter in Claim 12 is dependent on Claim 2, the subject matter of which is incorporated in Claim 12. Neither the Japanese reference nor the AAPA disclose, teach or suggest a first polishing step being conducted such that the interconnect metal film remains in 50% to 30% inclusive of the surface area other than the concave. Thus, the combination does not suggest such a step. Even the Office Action concurs, as it did not reject Claim 2 on this ground. Thus the rejection of Claim 12 on this ground is obviated; withdrawal thereof is respectfully requested.

The subject matter of Claim 32 is directed to a process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing using a polishing slurry comprising a silica polishing material and an inorganic salt, wherein the inorganic salt in the polishing slurry used in polishing is at least one selected from the group consisting of a hydroacid salt, an oxo acid salt, a peroxo acid salt and a halogen oxo acid salt and wherein the barrier metal film is a tantalum containing metal film and the interconnect metal film is copper or copper alloy film. The subject matter in Claim 28, as amended, incorporates the subject matter of Claim 29. Neither the Japanese reference nor the AAPA disclose, teach or suggest the use of a slurry comprised, inter alia, of an inorganic salt selected from the group consisting of a hydroacid salt, oxo acid salt or a peroxo acid salt and a halogen oxo acid salt. Even the Office Action concurs, as it did not reject Claim 29 on this ground.

Thus, for the reasons provided the rejection of Claims 12 and 32 under 35 U.S.C. §103(a) is obviated; withdrawal thereof is respectfully requested.

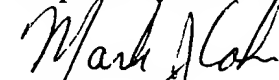
Pursuant to the rejection of Claims 22 and 27 under 35 U.S.C. §103(a), the Office Action cites the Japanese reference and Kyle and further in view of AAPA.

Kyle is not a proper reference as indicated hereinabove. Its publication date is September 8, 2000, which is after the filing of the priority application JP 11-374487, which was filed on December 28, 1999. Thus, Kyle cannot be combined with other references to sustain a rejection under 35 U.S.C. §103. Therefore, the Japanese reference, Kyle and the AAPA cannot be combined. Since neither of the remaining references discloses or teaches a polishing slurry comprising an organic acid or alkonalamine, as required in Claim 13 upon which Claim 22 is dependent, or a carboxylic acid of the formula recited in Claim 23, upon which Claim 27 is dependent, the rejection of Claims 22 and 27 on this ground is obviated; withdrawal thereof is respectfully requested.

Applicants have reviewed the other references cited but not applied in the Office Action, but they are deemed not to be pertinent to the present invention.

Therefore, in view of the Amendments to the claims and the remarks hereinabove, it is respectfully submitted that the present case is in condition for allowance, which action is earnestly solicited.

Respectfully submitted,



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"VERSION WITH MARKINGS TO SHOW CHANGES MADE"

IN THE CLAIMS:

Claim 29 has been canceled without prejudice.

Claims 2, 12 and 28 have been amended as follows:

2. (Amended) The process for forming a metal interconnect as claimed in Claim 1, wherein the first polishing step is conducted such that the interconnect metal film remains in 5% to 30% [both] inclusive of the surface area other than the concave.

13. (Amended) The process for forming a metal interconnect as claimed in Claim [1] 2 wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.

28. (Amended) A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film on the insulating film formed on a substrate, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing using a polishing slurry comprising a silica polishing material and an inorganic salt, [.] wherein the inorganic salt in the polishing slurry used in polishing is at least one selected from the group consisting of a hydroacid salt, an oxo acid salt, a peroxo acid salt and a halogen oxo acid salt.

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